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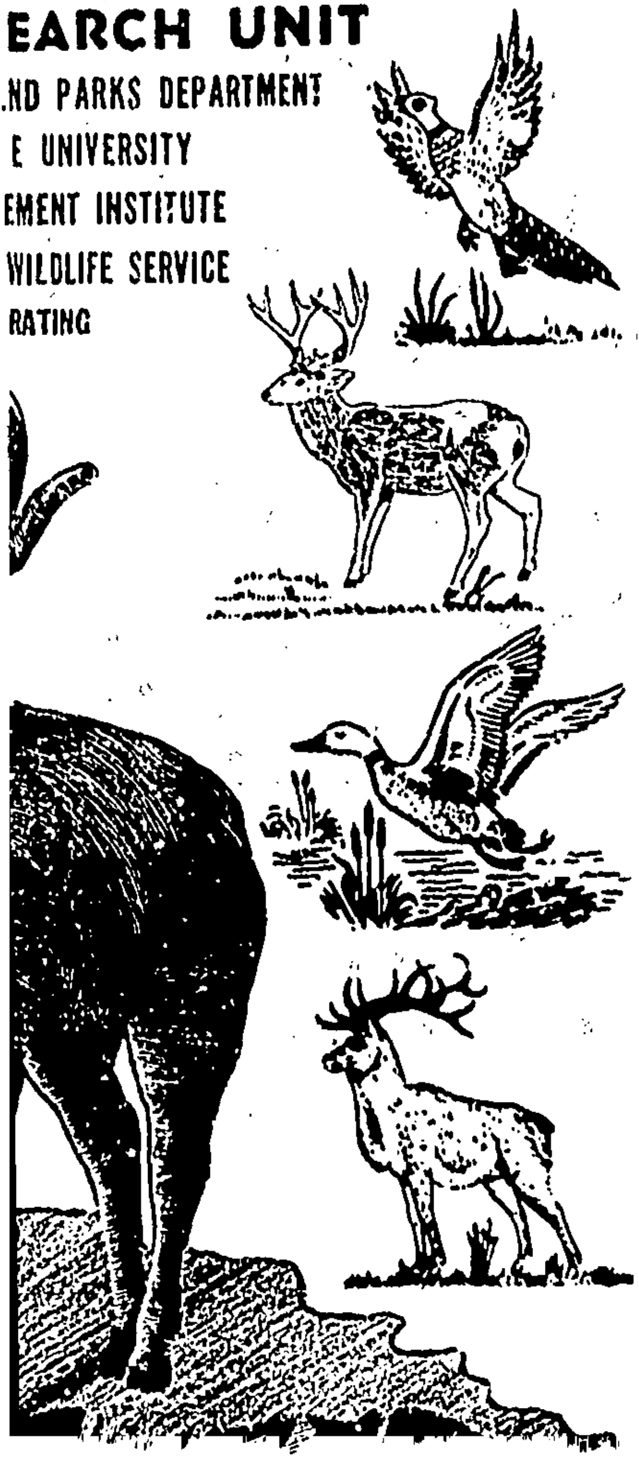

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ESTIMATING TIME OF DEATH IN MALLARDS

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ESTIMATING TIME OF DEATH IN MALLARDS

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This presentation is a progress report of a study conducted for the past six months at Colorado State University as part of the research program of the Colorado Cooperative Wildlife Research Unit. The research was financed by the Bureau of Sport Fisheries and Wildlife, Division of Management and Enforcement. The purpose of this project was to develop a method of estimating time of death in mallards. The people in the Bureau who initiated the project feel that such a method is needed by enforcement officers checking hunters in the field. An accurate estimate of how long a duck has been dead would sometimes give an indication (or substantiation) of whether or not it had been taken illegally: you could establish, within a certain margin of error, whether or not it was killed within shooting hours. The data I've collected have been taken entirely from drake mallards, 18 birds in all. The same methods will no doubt apply to many birds; when and if the technique proves useful for mallards, research may be extended to other game species. Limited investigations of the rate of body temperature change in dead waterfowl as an indicator of time of death have been made previously (Morrison and Hunt, 1963).

The methods we have found useful for time of death determinations in mallards are generally parallel to those used by coroners in human legal medicine. Gross changes, requiring only observation or simple measurements, have proved most satisfactory. Studies of the same kind on white-tailed deer in Maine have indicated the same thing (Gill, 1962). Over several years of study these workers found that the more complicated procedures, requiring exacting measurements and laboratory examination, were generally impractical for field use and often gave poor results even under laboratory conditions. Their most useful indicators of time since death were carcass temperature, appearance of the eyes, and stage of rigor mortis; over the short period I have spent on the problem I have concentrated primarily on these same three indicators. Also, I have had limited success with another, the resistance offered by muscle tissue to the passage of an electrical current. As in human legal medicine, a final technique in post-mortem aging must be based on several indicators; the variables involved are so numerous that no single factor can be depended on by itself.

To gather data on these indicators ducks were trapped near Colorado State University and, shortly afterwards, killed under controlled laboratory conditions. Time of death was carefully noted, and observations were made thereafter at regular intervals, each hour in most cases. Observations were continued through at least 24 hours with all the birds killed; several of the first ones were observed for periods up to 30 hours, but few notable changes occurred after 24 hours post-mortem. All of this was carried out under constant temperature conditions, since we considered air temperature to be one of our most important variables affecting the rate at which body heat was lost; observations were made at temperatures considered most likely to prevail during waterfowl hunting. Weight and amount of surface fat were recorded for each bird, as these were expected to influence the rate of body cooling also. Several birds were immersed in water after death to see if evaporation from the plumage would markedly increase rate of cooling. The body temperature of the duck, as well as being an indicator of time since death, was a suspected variable affecting the other body changes under observation; it is constantly changing, of course, but at a rate determined by the other variables I have mentioned.

Body temperature was recorded at two points of measurement for each duck. One thermometer was inserted about 3 inches into the bird via the cloaca and intestinal tract; another was inserted for about the same depth just anterior to and below the sternum, coming to rest within the body cavity. The body temperatures recorded from the thoracic position generally were higher than the corresponding cloacal ones, the difference ranging from 2 to 6 degrees Fahrenheit in the first few hours after death. After 10 or 11 hours post-mortem readings from the two positions were more or less the same. Temperatures of living mallards seem to range from about 106 to 108 degrees Fahrenheit; stress in handling may account for a good deal of the variation found. There is some evidence to suggest that the body temperature increases slightly at the time of death; I have found the temperature of some freshly killed birds to be as high as 110 degrees Fahrenheit.

After death the body temperature of the bird falls rapidly, but at a decreasing rate; the more closely the body temperature approaches a constant air temperature for each observation made, and the logarithm of each differential then found, a plot of these logarithmic values against time after death gives a straight line. The rate at which body cooling is taking place is described by the slope of the line. The regression constant, or b value, of the line may then be considered as the cooling constant of the particular bird in question. The value of the cooling constant is affected by bird weight, amount of insulating fat, and probably many other factors; but it is independent of air temperature (Morrison and Hunt, 1963).

We have tried to determine the value of cooling constants for mallards and how much they will vary over a normal range of bird conditions. More data are needed, however, to fully cover this range of variables. From what we have now, and later more fully, representative cooling constants will be used to construct a series of tables or curves describing how body temperature changes with time after death under a series of different conditions.

The eyes of dead mallards were found to change in appearance in a rather predictable manner over a span of perhaps 15 hours after death. These changes could be expected to give only a very "rough" indication of time after death because of the nature of the changes and the extreme variability present. But they could be useful under special circumstances, and they add another factor to the composite picture being formed. During the first few hours after death the pupil changes from a dark bluish-black to become light blue and clear; the eye loses turgor, and small indentations appear. Generally by the third or fourth hour, but often more delayed, other changes occur: the pupil becomes sunken and flat, while the iris does not sink but forms a raised circle above and around the pupil. As this occurs the iris typically changes in color from brown to purple. Later, from 10 to 24 hours postmortem, the iris sinks to become first flat, and finally sharply concave. Any later changes were prolonged and slight.

The time required for muscular stiffening to reach completion in different parts of the body is an important technique for establishing time of death in human legal medicine. The work in Maine on white-tailed deer also has revealed a natural pattern of stiffening among different muscles of the body. With knowledge of the pattern and the time intervals involved, an estimate of time since death can be made after examination of the carcass. However, this requires a familiarity with the "feel" of different levels of stiffening in different body parts; some parts may be much more rigid under full rigor than others. The usefulness of this technique is much reduced after all muscles are in full rigor; natural relaxation of the muscles is usually quite prolonged and variable. The limb joints of some of the deer observed in Maine were still quite stiff after 10 or 11 days post-mortem (Gill, 1962).

With the mallards I examined all body parts were generally in full mortis after 1 1/2 hours after death. Degree of rigor was gauged by "feel" (applying slight pressure to test the elasticity of a muscle) in the muscles of the breast, legs, neck, and bill and scored as none, slight, moderate, or rigid. A consistent pattern of stiffening in these parts was just not apparent from the birds I observed. Probably certain parts tend to stiffen more quickly than others, but normal variability obscures the pattern over such a short over-all interval. This method of comparing degree of stiffening in different body parts will probably never be very useful for post-mortem aging of ducks, but "rough" estimates of time after death should still be possible by gauging the general level of rigor up to about 1 1/2 hours.

One idea that we felt worth investigating was a possible change in resistance offered by muscle tissue to the passage of an electrical current after death. We thought it likely that the electrical resistance of the muscle tissue would be highest at the time of death, when the tissue was still living, and then decrease in some fashion as the tissue died and the structure of cells and their separating membranes changed. I have not yet seen any reference to other work of this kind having been done. The best instrument we could find to take accurate resistance measurements of this kind was a Wheatstone bridge, which measures unknown values by comparison with known and adjustable resistors. To establish a constant gap of muscle tissue across which we could measure resistance, we devised a pair of electrodes which were to be inserted vertically into a muscle (their length was 1 cm, and the gap between them 1 cm). This unit was connected to the instrument by a pair of lead wires.

Measurements were made on the pectoral muscles, lifting back the skin to expose them. Two measurements were made at each position used on a muscle: one measuring resistance parallel to the muscle fibers and another perpendicular to the alignment of the fibers. Direct current was tried for the measurements, but alternating current gave much better results. Observations on two birds showed the resistance values to drop very rapidly at first, then more slowly until finally little change was noted. The initial readings taken perpendicular to the alignment of muscle fibers were much higher than the corresponding parallel readings; then as both readings fell they became more nearly equal. The perpendicular readings took 3 to 6 hours longer to reach the common base level. This technique has possibilities of being very useful in determining time of death, but many more observations must be made to determine its reliability.

Some attention was given to other possible techniques of post-mortem aging. One of these was the change in muscle tissue pH values occurring after death. If enough change occurred, it might be a useful indicator of time since death. After much difficulty in measuring muscle pH accurately, an implant of a pH electrode was made into the pectoral muscle of a freshly killed mallard. Readings of a pH meter at 5 minute intervals showed a decrease in muscle pH of less than 0.5 of a pH number over a period of 2 hours post-mortem; no further change could be noted. Such a small change would be of little use in time of death estimations.

An attempt was made to measure the force required to detach certain feathers from mallard wings and learn whether this force changed with time after death. Poor equipment prevented reliable measurements from being made, and these investigations were temporarily discontinued.

In summary, post-mortem investigations in mallards have revealed several methods which can be useful in estimating time of death. The one most valuable indicator of time of death is body temperature, but electrical resistance of muscle tissue may prove nearly as reliable. Appearance of the eyes and extent of rigor mortis are also useful. Time of death estimates will be most reliable when all indicators are taken into account.

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